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ABSTRACT

The purposes of this study were to determine the effects of previous training in agricultural mechanics upon achievement of students enrolled in a college level agricultural mechanics course and to determine factors that affect performance in this course of basic metals and welding. Students enrolled in the course during the fall and winter quarters of 1977-78 at Iowa State University comprised the research sample of 204. Data were collected from three sources: a survey administered during the final week of each quarter; a mechanical aptitude test given during the first week of winter quarter; and laboratory, lecture, and course totals obtained from each instructor involved in the study. From the findings these are some of the conclusions drawn: students who had received high school instruction in vocational agricultural and industrial arts did not perform significantly better than those who did not; and mechanical aptitude test scores were not significantly different for those who had previous agricultural mechanics instruction compared to those who did not. (Measurement instruments are included in the appendix.) (JH)

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Effect of previous agricultural mechanics training on achievement in a basic metals and welding course at Iowa State University

by

Benjamin Arthur Yoder

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Major: Agricultural Education

Approved:

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INTRODUCTION

The passage of the Smith-Hughes Act of 1917 brought out the role of education in equipping young people with usable and marketable skills. The 1963 Vocational Education Act and the 1968 and 1976 Vocational Amendments reinforced in Smith-Hughes Act of 1917. Considerable change and interest has taken place in secondary and post-secondary vocational programs as a result of this legislation. Post-secondary and secondary programs have increased in variety and number. More emphasis is being placed on technical skills that can be applied directly to the job. Educators, parents and students have expressed a great deal of concern in recent years about hands-on experience. This is nothing new in the field of agriculture. Jones and Guidry (13, p. 134) stated:

> We often speak of the student and it is indeed that student who is the final product of our educational process. The student must possess a marketable skill and be able to contribute a measurable input into society.

Vocational agriculture programs have been continually modified to meet the increasing demand of providing students with sufficient skills that can be used for employment. The development of agricultural mechanics skills involves much more than just the presentation of facts and information to the student. Leighbody and Kidd (15, p. 2) made these comments on skill development:

> In attempting to understand how individuals learn new skills or ideas, it is important to know what part is played by the learner. One of the first things to realize is that the teacher cannot give the learner any skill or knowledge by simply presenting this skill or knowledge to the student. It is not a matter of transferring what the teacher knows into the hands or minds of his pupils. The one who is to learn

> must do something in which his mind and muscles will take on new ways of behaving. He must not only receive new ideas or skills from the teacher by observing and listening, but he must attempt to use these skills and ideas himself. It is only when the pupil is engaged in putting into practice what he has seen, heard, or read, that the learning process becomes complete.

Educators in the past have been concerned about the value of high school vocational training as preparation for college as well as developing skills that are suited for employment. Research has been conducted in the past concerning achievement in agricultural curricula of former vocational agriculture students. Hoerner (12) concluded that vocational agriculture students tended to achieve at higher levels than did nonvocational agriculture students in selected agricultural mechanics courses.

The main objective of this study was to measure the effect of previous agricultural mechanics training as it related to achievement of those students involved in the beginning metals and welding course at Iowa State University of Science and Technology. The main objective of this study can be broken down into two major purposes, these being:

1. Measure the effect of previous agricultural mechanics training as it related to achievement in Agricultural Mechanics 254.
2. To identify factors that effect student achievement in Agricultural Mechanics 254 from a selected list of variables.

REVIEW OF LITERATURE

This review of literature is divided into three areas: the first section looks at achievement in a basic welding and metals course at Iowa State University, the second is a review of achievement in a specific college course other than Agricultural Mechanics 254 and third is a review of achievement in college.

Achievement in a Basic Metals and Welding Course

In 1949 O'Brien (18) determined whether curriculum patterns of male students with farm backgrounds influenced achievement in Agricultural Engineering 254. The sample consisted of 184 freshman students who entered the College of Agriculture at Iowa State University during the fall quarters of 1946, 1947 and 1948. The students were divided into four subgroups for the purpose of categorizing those who had training in vocational agriculture, industrial arts, in both vocational agriculture and industrial arts or in neither vocational agriculture or industrial arts in high school.

When O'Brien compared the actual achievement marks in farm mechanics made by graduates from the various high school curriculum patterns, he found that: (1) when other groups were compared with the group having neither vocational agriculture nor industrial arts, the group having had vocational agriculture excelled by 0.37 of a grade point; and (2) the group having had both vocational agriculture and industrial arts excelled by 0.31 of a grade point. T-values of 2.29, 0.50 and 1.10 were found for the vocational group, the industrial arts group and the interaction, respectively. The t-value of 2.29 was significant at the five percent level when no controls were used.

Using an analysis of covariance, O'Brien found students who had taken vocational agriculture in high school received a significantly higher grade average in the beginning farm mechanics course than the students who had vocational agriculture in high school.

In conclusion, O'Brien stated that students having had neither vocational agriculture nor industrial arts were somewhat at a disadvantage in Agricultural Engineering 254 at Iowa State University.

Stevenson (21) in 1956 studied the influence of high school vocational agriculture as it related to suggested farm mechanics jobs completed by graduates prior to entering Iowa State College. Two hundred students were surveyed from 371 qualified participants in Agricultural Engineering 254. Stevenson randomly selected 100 graduates who had vocational agriculture and 100 graduates who had not received any vocational agriculture training in high school. Seventy-five skills and a list of 46 commonly used tools were looked at in the areas of farm buildings, farm shop, farm power and machinery, farm electrification and soil and water management.

Forty-four percent of nonvocational agriculture graduates hired their welding jobs done compared to eight percent for vocational agriculture graduates. Stevenson also noted that the vocational agriculture group completed 36 percent of the possible 75 jobs compared to 26 percent for the nonvocational agriculture group.

A chi-square analysis revealed a significant difference at the one percent level in the number of jobs performed with vocational agriculture students scoring higher. Enrollment in high school vocational agriculture did influence the level of achievement in Agricultural Engineering 254.

The effect of vocational agriculture on student achievement in an introductory farm mechanics course at Iowa State University was studied by Fulton (9) in 1956. Data for the study were collected from 200 students who were surveyed from 237 qualified participants. One hundred former vocational agriculture students were randomly picked along with 100 nonvocational agriculture students.

A high positive relationship existed between participation in high school vocational agriculture and skills that were used in the farm mechanics area prior to enrolling in Agricultural Engineering 254. With the final mark in Agricultural Engineering 254 as the criterion, an analysis of variance was made in which the mean marks of the vocational agriculture students were compared with the mean marks of the nonvocational agriculture students. A f-value of 2.36 which was significant at the five percent level was obtained, which indicated that vocational agriculture students had a definite advantage over nonvocational agriculture students. Fulton concluded this study by noting that vocational agriculture students with previous agricultural mechanics instruction tended to achieve at a higher level than nonvocational agriculture students.

The effect of high school vocational agriculture on student achievement in agricultural mechanics has been studied by Hoerner (12) in 1963. A total of 251 male students who enrolled in one or more of four selected agricultural engineering courses in the fall of 1955 and graduated by 1961 made up the sample of this study.

Positive significant correlations that existed at the five percent level were found between: (1) semesters of high school vocational agricul-

ture and third quarter final college quality point average; (2) semesters of high school vocational agriculture and grade in Agricultural Engineering 254; and (3) semesters of high school vocational agriculture and high school quality grade point average. Hoerner concluded that those students who had vocational agriculture in high school tended to achieve at a higher level than did nonvocational agriculture students.

Peyton (19) in 1970 studied the effect of demonstration group size and skill procedure sheets on the development of a manipulative skill. Fifty-nine Agricultural Engineering 254 students were selected during the spring of 1968 to make up the sample. The Owens-Bennett mechanical aptitude test was administered to all the students besides a pretest, questionnaire, posttest and the graded drill bit score sheet were used to collect the data.

Previous experience, posttest score and the Owens - Bennett mechanical aptitude test were all significantly correlated. Experience in vocational agriculture and industrial arts appeared to have little effect on student achievement in subject matter related to drill sharpening. From this study Peyton concluded that previous experience did have a significant effect on the student's ability to sharpen the twist drill. He also concluded that three or four in a group was most ideal for the purpose of demonstration.

Achievement in a Specific College Course

Achievement in a beginning poultry course of those students who had vocational agriculture in high school as compared to the achievement by nonvocational agriculture students was studied by Gamble (10) in 1949.

Using the final mark in the course as a criterion, an analysis of variance was made in which the mean marks of the vocational agriculture group were compared with the mean marks of the nonvocational agriculture group. No significant differences were found in the final grades received in a beginning poultry course at Iowa State University by students who had and those who had not taken at least three years of vocational agriculture in high school. Gamble concluded that students in the beginning poultry course were not penalized because of the high school curriculum they had prior to enrolling at Iowa State University.

Drake (8) in 1949 conducted a study to determine what effect vocational agriculture had as preparation for a college course in dairy industry. The records of 256 students entering the College of Agriculture as freshmen in the fall quarters of 1946 and 1947 were secured.

Using the final mark in Dairy Industry 114 as the criterion for achievement an analysis of variance of the difference in the mean mark for vocational agriculture students was compared with the mean mark received by the nonvocational agriculture students. No significant difference was obtained. Controlling for farm background, a significant difference in achievement in Dairy Industry 114 was found in favor of those students having a farm background. Drake concluded that no evidence of superiority was shown for either the students who had vocational agriculture in high school or who had no instruction in vocational agriculture, so long as achievement was evaluated in terms of the final mark assigned.

Carter (7) in 1949 conducted a study to determine the effect of vocational agriculture in high school as preparation for a freshman botany

course at Iowa State University. By random sampling, Carter selected 336 students who entered the College of Agriculture in the fall quarters of 1947 and 1948. One group of 224 was composed of farm youths, of which one-half had presented three or more Carnegie units in vocational agriculture. A second group consisted of 224 students who had presented less than three Carnegie units of vocational agriculture; one-half whom were farm youths and one-half of whom were non-farm youths.

An analysis of variance of the difference in the final marks in Botany 101 between the vocational agriculture and nonvocational agriculture farm youths failed to show any significance.

Using the first quarter final mark in English and the ACE score as controls on scholastic ability and aptitude, an analysis of covariance was made using the final mark in Botany 101 as the criterion. A highly significant difference was found between the farm youths having had vocational agriculture and farm youths not having had vocational agriculture in high school.

Carter concluded that there were factors which caused those freshmen who had vocational agriculture in high school to receive significantly higher grades in Botany 101 than those who were graduates of a nonvocational agriculture curriculum.

In 1962 a study was conducted at Iowa State University by McCracken (17) which involved the records of 309 freshmen male students enrolled in the College of Agriculture during the fall quarter of 1955. The purpose of the study was to determine the relationship that existed between academic achievement in college agronomy courses and the number of semester credits of high school vocational agriculture students.

A coefficient of correlation was significant at the five percent level when semesters of high school vocational agriculture were compared with high school quality point average. Students who took vocational agriculture in high school tended to have higher high school achievement. McCracken concluded that high school quality point average was the best predictor of achievement in agronomy courses at Iowa State University although semesters of vocational agriculture negatively correlated with achievement in agronomy courses.

Achievement in College

McCalley (16) in 1930 conducted one of the earliest studies in comparing high school vocational agriculture and achievement in college courses in agriculture. He investigated the records of all students who entered Iowa State University from the year 1920 to the fall of 1928. His main purpose was to compare the success of students in college who had studied vocational agriculture with the success of the average college student to determine whether vocational agriculture training had any apparent influence on their college records. He compared the average marks for the male students of each class with the average marks made by those who had studied vocational agriculture in high school. In conclusion McCalley (16, p. 53) stated:

> Vocational agriculture graduates made an average grade in the Iowa State College as high as the average grade of all students.
>
> The percentage of vocational agriculture graduates in the higher intelligence rating group were lower than the percentages of college freshmen in those groups.

Vocational agriculture may be taught to students in the high schools without interfering with their preparation for college.

Bicknell (4) studied 997 male freshmen students who enrolled in the College of Agriculture at Iowa State University during the fall quarters of 1946, 1947 and 1948. The purpose of his study was to evaluate college achievement in relation to high school backgrounds. The student records were subdivided into the following four groups according to the number of Carnegie units they had earned in each of the high school subject areas: (1) vocational agriculture for those who had three or more units of this subject; (2) vocational subjects other than agriculture for those who had six or more units; (3) mathematics-science for those who had six or more units in these areas; and (4) general high school experience for the remainder of the group. The criteria of achievement used by Bicknell were (1) honor point ratio earned in first quarter agriculture courses; (2) mark received in the initial course in chemistry; and (3) attrition-survival beyond the freshman year.

Bicknell found when each high school pattern was compared with each of the others, the vocational agriculture group was found to have the highest achievement and the general pattern group was found to have the lowest achievement in agriculture. From this study he concluded that the vocational agriculture pattern gave the best preparation, while the general pattern gave the poorest preparation for achievement in the College of Agriculture.

Hensel (11) in 1955 wanted to determine factors which influenced the acad mic achievement of undergraduate students who had entered one of the four colleges at Iowa State University during the fall of 1955. Two samples were used throughout the study and were divided on the basis of quarters completed. Two thousand and thirteen students who had completed one quarter of college work made up the first sample and 1650 students who completed three quarters of college work made up the second sample.

For statistical purposes the students were divided in to five groups within the four colleges:

1. Agriculture males
2. Engineering males
3. Home Economics females
4. Science males
5. Science females

Hensel concluded (11, p. 90):

> Significant relationships did exist between certain pre-college variables and achievement in the different colleges at Iowa State University. Those variables which were most useful as predictors were high school grade point average, the mathematics placement test score and the English placement test score. Once the student had completed one quarter at the University, the best predictor of future grades of graduation tended to be the student's most recent college grade point average. The longer the student remained in college, the more useful the cumulative college grade point became as a predictor of academic achievement at Iowa State University.

Construction and validation of a skill test for farm mechanics was researched by Thompson (23) in 1955. Nine hundred eighteen students from 21 randomly selected qualifying schools participated in the study. The sample skills of sawing, reading a plan, hot metal work, threading, welding,

and replacing a mower ledger plate were selected and job sheets were developed for the uniform evaluation of all student skill activities. The local vocational agriculture instructor evaluated all the jobs performed by his students using the provided evaluation score sheet. All materials were then returned to Iowa State University, and were evaluated by three knowledgeable instructors in the Agricultural Engineering Department. Analysis of covariance revealed a significant difference between the mean scores given by the three agricultural engineering instructors and the local instructor, with the local instructor scoring higher in all cases. All evaluation instruments were revised by deleting unimportant factors and weighting the remaining factors.

Ball (2) in 1956 conducted an investigation to determine the effectiveness of high school vocational agriculture on farm mechanics used by participants in the veterans farm training program.

One hundred nineteen vocational agriculture and 258 nonvocational agriculture graduates made up the sample.

A fifty-six item schedule with 29 items involving manipulative jobs or skills, 15 items involving managerial decisions, and 12 items involving farm shop equipment generally found on Iowa farms was administered to the sample.

Ball concluded from his study that vocational agriculture students who were in the group classified as having status in farming were found to be performing a proportionately greater number of recommended farm mechanics activities in certain areas than were former nonvocational agriculture students. He further concluded for future high school programs in vocational

agriculture in Iowa additional emphasis should be placed upon the farm mechanics activities in his study.

In 1959 Bear (3) looked at the relationship of high school vocational agriculture to mechanical farm jobs performed by graduates. Forty-five schools which had offered vocational agriculture during 1943-54 were paired with schools that had not offered vocational agriculture during the same period. Twenty pairs were randomly selected from the original forty-five pairs along with 120 graduates. The sample was stratified according to type of training, farm ownership status of parents, period of graduation and size of home farm of graduates at the time of graduation.

From his study Bear concluded that additional consideration should be given to strengthening the farm mechanics offered in the Iowa high school vocational agriculture programs. Bear (3, p. 102) stated:

> Data from this study did not indicate that farm mechanics instruction provided in high school vocational agriculture greatly influenced the farm mechanics practices used by graduates.

In 1960 a study was conducted by Thompson (22) at Iowa State University involving 388 freshmen in the College of Agriculture at Iowa State University. The purpose of the investigation was to determine the influence of vocational agriculture on performance of students in the College of Agriculture at Iowa State University. Thompson found that a negative relationship existed between the number of years completed of high school vocational agriculture and of high school science and mathematics. A favorable influence of vocational agriculture was found on the scholastic attainment of students entering the College of Agriculture. It appeared that vocational

agriculture had value in developing and maintaining interest in a college education in agriculture. Thompson concluded that it would be best to develop a combination of mathematics, science and vocational agriculture subjects so that the courses would become complementary rather than competitive.

In 1961, Schmidt (20) conducted a study to determine the relationship that existed between the number of semesters of high school vocational agriculture and science and achievement in the College of Agriculture at the Iowa State University of Science and Technology.

His sample involved 287 male students who graduated from Iowa high schools in 1955 and entered as freshmen in the fall of 1955 in the College of Agriculture.

He found a highly significant negative correlation between the number of semesters of vocational agriculture and semesters of science, which indicated that there was some substitution of science for vocational agriculture or vocational agriculture for science courses in the high school curriculum.

An analysis of the intercorrelations of 16 variables was performed and the coefficients of correlation were obtained. He found a highly significant correlation at the one percent level between first-quarter quality point averages and semesters of high school vocational agriculture.

The effect of class size and total department enrollment of 42 selected Iowa high school vocational agriculture departments were studied by Tindall (24) in 1969. Random assignment of the 42 schools to seven different media treatments provided 168 classes to be studied.

Significant differences were not found in achievement between students in the large and small departments, however, the smaller size was favored. Achievement tended to decrease as the total size increased.

Breece (6) in 1972 conducted a study to determine the content and emphasis in agricultural mechanics instruction provided by public supported educational agencies in Iowa for the fiscal year 1970-71.

Seventy-five secondary vocational agriculture programs, cooperative extension services and twelve area schools made up the sample.

Breece found that 27 percent of the total instructional time in vocational agriculture was devoted to instruction in agricultural mechanics. Breece (6, p. 149) stated:

> To a large extent, technological advancements in the mechanical phases of farming have enabled production agriculture to be the nation's most efficient business.

It was concluded that secondary schools, post-secondary schools and county extension services should cooperatively evaluate the understandings, skills and abilities needed in agricultural mechanics in their respective communities. Following a careful examination of resources available, an articulated program in agricultural mechanics should be developed.

Summary

Previous research points out that vocational agriculture training in high school does have a positive effect on student performance in Agricultural Mechanics 254. Students who have received vocational agriculture instruction in high school and enrolled in other courses besides Agricultural Mechanics 254 were not penalized in their performance in these courses. Vocational Agriculture as preparation for college appears to have a favorable influence on those students who are enrolled in the College of Agriculture.

METHOD OF PROCEDURE

Statement of the Problem

Vocational education in the past fifteen years has undergone much change in order to meet student needs. The 1963 Vocational Education Act and the 1968 and 1976 Vocational Amendements have been primary catalysts. Legislation regarding vocational education has brought renewed interest and financial support to vocational education throughout the public school system. More emphasis is being placed on technical skills that can be applied directly to the job.

The purpose of this study was to determine the effects of previous training in agricultural mechanics upon achievement of students enrolled in Agricultural Mechanics 254. A second purpose was to determine factors that affect performance in Agricultural Mechanics 254.

Hypotheses

1. There is no significant difference in achievement between students who had previous agricultural mechanics instruction and those who did not.
2. There is no significant difference in achievement between students who had vocational agriculture in high school and nonvocational agriculture students.
3. There is no significant difference in achievement between students who had industrial arts in high school and nonindustrial arts students.
4. There is no significant difference in aptitude scores between students who had previous agricultural mechanics instruction and those who did not.

5. There is no significant difference in achievement between students who received instruction in high school in the following areas and those who did not:

   1. Arc welding

   2. Oxy-acetylene welding and cutting

   3. Hot and cold metals

6. There is no significant difference in achievement between students who had completed one or more welding jobs in arc welding and oxy-acetylene welding and cutting and those who had completed none.

7. There is no significant difference in achievement between students who had completed one or more metal jobs and those who have completed none.

8. There is no significant difference in achievement between students who had ten or more experiences with the following tools and those who had nine or fewer experiences:

   1. Metric micrometer

   2. Metric vernier caliper

   3. English micrometer

   4. English vernier caliper

   5. Tap and die set

   6. Tool grinder

   7. Power hacksaw

   8. Hand hacksaw

   9. Forge and anvil

   10. Arc welder

   11. Oxy-acetylene welder

   12. Drill press

   13. Oxy-acetylene cutting torch

   14. Metal working hand tools (file, scribe, center punch, ballpeen hammer)

Design of the Study

This study was designed to measure the effect of previous training in agricultural mechanics upon achievement in Agricultural Mechanics 254.

The design of this study can best be classified as an ex post facto study. Borg and Gall (5, p. 297) stated:

> The causal-comparative method is aimed at the discovery of possible causes for a behavior pattern by comparing subjects in whom this pattern is present with similar subjects in whom it is absent.

Two hundred four students participated in the study conducted during the fall and winter quarters of the academic year of 1977-78 at Iowa State University. Ten laboratory sections of Agricultural Mechanics 254 were taught during fall quarter and six sections were taught during winter quarter with seven instructors involved in the study. Data were collected from three sources, those being: (1) a survey (Appendix) administered during the final week of each quarter, (2) a mechanical aptitude test given during the first week of winter quarter and (3) laboratory and lecture totals obtained from each instructor involved in the study.

Tests

Three tests were administered during each quarter in lecture covering the areas of metals, oxy-acetylene welding and arc welding. Each test was worth one hundred points and was developed by the author with the assistance of all instructors in Agricultural Mechanics 254. The results of each test were subjected to an item-analysis study from the Test and Evaluation Service at Iowa State University where an average reliability estimate of .70 was found for all three tests.

The Bennett, Seashore and Wesman Mechanical Reasoning Aptitude Test, Form T, was administered to winter quarter students only. It was not administered during the fall quarter because copies of the test could not be obtained until winter quarter.

The evaluation score sheet that was used to evaluate the metal projects (Appendix) was developed and refined by instructors in the Agricultural Engineering Department at Iowa State University.

Treatment of Data

Data collected from each participant were: (1) fifty-four items on the survey form, (2) total laboratory points and (3) total lecture points. Scores from the mechanical aptitude test were obtained only from the winter quarter students and were based on 100 points. The lecture points were totaled from three tests, each being worth 100 points. The laboratory part of the course totaled 365 points. Points were totaled from: (1) 15 welds, each being worth ten points, (2) two trophies at 25 points each and (3) six metal projects totaling 165 points. Data were collected and coded on International Business Machine cards (IBM) for further analysis.

Statistical Analysis

Lapin (14, p. 363-4) stated:

> The goal of correlation analysis is to measure the degree to which two variables are related.

Intercorrelations among all variables were computed and 23 variables were selected and arranged in a variable matrix. The following variables were arranged in the correlational matrix:

1. Classification at Iowa State University

2. Rank in high school class
3. Major
4. Background
5. Age
6. Semesters of high school vocational agriculture
7. Semesters of high school industrial arts
8. Semesters of agricultural mechanics training received at a post-secondary institution outside of Iowa State University
9. Weeks of agricultural mechanics training received in high school
10. Weeks of arc welding instruction received in high school
11. Weeks of oxy-acetylene welding instruction received in high school
12. Weeks of hot and cold metal instruction received in high school
13. Arc welders at home
14. Oxy-acetylene welders at home
15. Agricultural mechanics 254 as it compares to other courses at Iowa State University
16. Total tool and equipment experience
17. Total metal jobs completed
18. Total oxy-acetylene welds completed
19. Total arc welds completed
20. Total laboratory points
21. Total lecture points
22. Total course points
23. Mechanical aptitude test score

Ary and Jacobs (1, p. 327) stated:

> The magnitude of the difference between the means of the two samples must be evaluated so that the researcher can decide whether the observed difference probably is or probably is not a result of chance. The t-ratio is used for this purpose.

T-tests were performed on selected independent variables. Each variable was divided into two groups in order to conduct the test. Those students who had no previous experience made up the first group and those who had previous experience made up the second group. This held true for all variables except for total tool experience where nine or fewer experiences served as the break point. T-tests were performed on the following variables:

1. Semesters of high school vocational agriculture
2. Semesters of high school industrial arts
3. Weeks of agricultural mechanics training received in high school
4. Weeks of arc welding instruction received in high school
5. Weeks of oxy-acetylene welding instruction received in high school
6. Weeks of hot and cold metals instruction received in high school
7. Total tool and equipment experience
8. Total metal jobs completed
9. Total oxy-acetylene welds completed
10. Total arc welds completed

Each of the above independent variables were tested against the following dependent variables:

1. Total laboratory points

2. Total lecture points

3. Total course points

4. Mechanical aptitude test score

Assumptions

1. All students had an equal opportunity to see, hear, practice and learn the presented material.

2. Differences in demonstrations and individual instructor techniques produced no bias in the study.

3. Information obtained from the survey was correct and unbiased and accurately reflected the ability of the participants.

Limitations

From this study one cannot determine actual causes for a pattern of behavior but can only conclude on the degree of relationship that exists between independent and dependent variables. Borg and Gall (5, p. 298) stated:

> This limitation of causal-comparative research arises out of the fact that the research worker must start with observed effects and then attempt to discover the antecedent (causes) of these effects.

Inferences from this study can only be made to those students taking Agricultural Mechanics 254.

The evaluation score sheet used for evaluating the metal projects was not subjected to any type of reliability test. It is assumed that this sheet was a fair evaluation and was accurately used for the uniform evaluation of all projects.

The mechanical aptitude test was only administered to 65 participants

during the winter quarter. Copies of the test could not be obtained until that time.

Student survey items were approved through the Iowa State University Committee on the use of Human Subjects for Research and were prevented by law from searching past student records for additional personal and educational data.

Due to the number of students involved in the study it was not feasible to have one instructor teach all laboratory and lecture sections. The author tried to teach as many sections as possible. It is assumed that no bias was caused by this situation.

Definition of Terms

Agricultural Mechanics 254 - A course in metal construction and maintenance at Iowa State University dealing with the selection and application of ferrous and nonferrous metals. Specific units are taught in oxy-acetylene welding, arc welding and metals.

Mechanical Aptitude Test - A test designed to measure students' ability in mechanics.

Manipulative Skill - An acquired ability involving physical movements and application of learned principles.

FINDINGS

The Research Population

The purpose of this study was to determine the effects of previous training in agricultural mechanics upon achievement of students involved in Agricultural Mechanics 254. Students enrolled in Agricultural Mechanics 254 during the fall and winter quarters of the 1977-78 academic year were studied. Information in Table 10 reveals the research sample broken down by college curriculum. Farm Operations (50.5 percent) and Agricultural Education (23.0 percent) majors comprised the largest curriculums in the study.

Table 1. Student enrollment in Agricultural Mechanics 254 by college curriculum.

Student Major	Fall		Winter		Total	
	N	%	N	%	N	%
Farm operations	83	59.7	20	30.8	103	50.5
Agricultural education	32	23.0	15	23.1	47	23.0
Agricultural mechanics	7	5.0	18	27.7	25	12.3
Agricultural business	5	3.6	6	9.2	11	5.4
Animal science	5	3.6	2	3.1	7	3.4
Agronomy	2	1.4	1	1.5	3	1.5
Dairy industry	2	1.4	0	0.0	2	1.0
Other	3	2.2	3	4.6	6	2.9
Total	139	100.00	65	100.0	204	100.0

Some variation existed between majors with more enrolled in Agricultural Mechanics during the winter quarter than Agricultural Education. Ninety-seven percent of all students surveyed were in the College of Agriculture at Iowa State University.

The sample consisted of 17 seniors, 20 juniors, 40 sophomores and 127 freshmen. Data in Table 2 indicated that freshmen and sophomores totaled 82 percent of the samples with the remaining 18 percent being juniors and seniors.

Table 2. Student enrollment in Agricultural Mechanics 254 by academic grade level.

Grade Level	Fall		Winter		Total	
	N	%	N	%	N	%
Senior	10	7.3	7	10.8	17	8.3
Junior	11	7.9	9	13.8	20	9.8
Sophomore	23	16.5	17	26.2	40	19.6
Freshmen	95	68.3	32	49.2	127	62.3
Total	139	100.0	65	100.0	204	100.0

Eighty-five percent of the students involved in Agricultural Mechanics 254 during the research period came from a farm background as indicated in Table 3. The remaining 15 percent came from a farm related or nonfarm background.

Table 3. Student enrollment in Agricultural Mechanics 254 by background.

Background	Fall		Winter		Total	
	N	%	N	%	N	%
Farm background	119	85.6	55	84.6	174	85.3
Farm related	11	7.9	6	9.5	17	8.3
Non-farm	9	6.5	4	5.9	13	6.4
Total	139	100.0	65	100.0	204	100.0

Analysis of Raw Data

Data in Table 4 indicated that students completed an average of 3.73 semesters of high school vocational agriculture, 2.72 semesters of high school industrial arts and 0.90 semesters of agricultural mechanics at a post secondary institution other than Iowa State University. Of the 204 students studied 50 percent had completed less than 2.90 semesters of high school vocational agriculture, 1.93 semesters of industrial arts and 0.05 semesters of post-secondary training outside of Iowa State University.

Table 4. Raw data analysis of semesters of high school vocational agriculture, industrial arts and post-secondary training.

Semesters	Vocational Agriculture		Industrial Arts		Post - Secondary	
	N	%	N	%	N	%
0	80	39.2	61	29.9	184	90.2
1-2	20	9.8	61	29.9	14	6.8
3-4	18	8.9	39	19.1	2	1.0
5-6	17	8.4	19	9.4	1	0.5
7-8	62	30.4	17	8.4	0	0.0
9-10	6	3.0	5	2.5	0	0.0
11+	1	0.5	2	1.0	3	1.5
Total	204	100.0	204	100.0	204	100.0
Mean	3.73		2.72		0.90	
Median	2.90		1.93		0.05	

Information in Table 5 reveals a mean of 41.4 weeks of high school instruction received in agricultural mechanics. A mean of 6.28 weeks of high school instruction was received in arc welding, 3.79 weeks in oxy-acetylene welding and 4.10 weeks in hot and cold metals. Of the students studied, 50 percent had received less than 29.75, 3.83, 1.53 and 0.34 weeks of high school instruction in agricultural mechanics, arc welding, oxy-acetylene welding and hot and cold metals, respectively.

Table 5. Raw data analysis of weeks of high school training received in agricultural mechanics, arc welding, oxy-acetylene welding and hot and cold metals.

Weeks	Agricultural Mechanics		Arc Welding		Oxy-acetylene Welding		Hot & Cold Metals	
	N	%	N	%	N	%	N	%
0	42	20.6	60	29.4	84	41.2	122	59.8
1-18	40	19.8	133	65.1	114	55.8	72	35.2
19-36	52	25.6	7.0	3.5	5	2.5	5	2.5
37-54	14	7.4	4.0	2.0	1	0.5	5	2.5
55-72	21	10.3	0	0.0	0	0.0	0	0.0
73-90	11	5.4	0	0.0	0	0.0	0	0.0
91-108	1	0.5	0	0.0	0	0.0	0	0.0
108-126	13	6.4	0	0.0	0	0.0	0	0.0
127-144	4	2.0	0	0.0	0	0.0	0	0.0
145 +	5	2.5	0	0.0	0	0.0	0	0.0
Total	204	100.0	204	100.0	204	100.0	204	100.0
Mean	41.4		6.28		3.79		4.10	
Median	29.75		3.83		1.53		0.34	

In the research sample 73 percent and 40 percent respectively had access to an arc welder and oxy-acetylene welder at home as indicated in Table 6. Further, 91 percent had not participated in a district or state agricultural mechanics contest.

Table 6. Raw data analysis of number of arc and oxy-acetylene welders owned at home and number of agricultural mechanics contests participated in on the district and state level.

N	Arc Welders		Oxy-acetylene Welders		Agricultural Mechanics Contests	
	N	%	N	%	N	%
0	50	24.5	121	59.3	186	91.2
1	140	68.6	72	35.3	12	5.9
2	8	3.9	11	5.4	4	2.0
3	6	2.9	0	0.0	2	1.0
Total	204	100.0	204	100.0	204	100.0

Student's ratings of Agricultural Mechanics 254 as it compares to other courses at Iowa State University by quarter of instruction are listed in Table 7. Values were obtained from a nine point scale with the number one meaning poor and nine meaning excellent. Winter quarter students produced a higher mean (7.32) and a lower standard deviation (1.37) than fall quarter students where a mean of 7.05 and a standard deviation of 1.37 were obtained. The overall mean rating for Agricultural Mechanics 254 was 7.14.

Table 7. Raw data analysis of student's rating of Agricultural Mechanics 254 as it compared to other courses at Iowa State University by quarter of instruction.

	Fall	Winter	Total
Mean	7.05	7.32	7.14
Standard deviation	1.49	1.37	1.46

Analysis of previous tool experiences prior to taking Agricultural Mechanics 254 are listed in Table 8. More than 50 percent of those students studied had no previous experience in the area of metric measuring tools. However, more than 50 percent of the research sample had experience with the following: tap and die set, tool grinder, power hacksaw, forge and anvil, arc and oxy-acetylene welders, drill press and selected metal working hand tools. Students had the opportunity to check either vocational agriculture, industrial arts, home farm or other to show where they had received experience in using a particular tool. A value of one was coded if they had experience with a particular tool in one of three areas. If a student had experience with a particular tool in all three areas, a value of three was coded for that particular tool. With 14 tools listed on the survey, (Appendix) it was possible to have a value of 42 for total tool experience. However, a total tool mean experience of 15.70 was obtained.

Table 8. Raw data analysis of tools used prior to taking Agricultural Mechanics 254.

Tool	Yes		No		Total	
	N	%	N	%	N	%
Metric micrometer	90	49.1	114	55.9	204	100.0
Metric venier caliper	73	35.8	131	64.2	204	100.0
English micrometer	101	49.5	103	50.5	204	100.0
English venier caliper	87	42.6	117	57.4	204	100.0
Tap and die	156	76.5	48	23.5	204	100.0
Tool grinder	182	89.2	22	10.8	204	100.0
Power hacksaw	157	77.0	47	23.0	204	100.0
Hand hacksaw	198	97.1	6	2.9	204	100.0
Forge and anvil	105	51.5	99	48.5	204	100.0
Arc welder	174	85.3	30	14.7	204	100.0
Oxy-acetylene welder	131	64.2	73	35.8	204	100.0
Oxy-acetylene cutting torch	146	71.6	58	28.4	204	100.0
Drill press	182	89.2	22	10.8	204	100.0
Hand tools	191	93.6	13	6.4	204	100.0
Total tool experience mean	15.70					

Data in Table 9 illustrate the means, medians and standard deviations for total metal jobs, total oxy-acetylene welds and total arc welds completed prior to taking Agricultural Mechanics 254.

A mean of 6.17 was calculated for total metal jobs, 70.85 for total oxy-acetylene welds and 239.93 for total arc welds completed prior to taking Agricultural Mechanics 254. Of the 204 students studied, 50 percent had completed less than 0.40 metal jobs, 12.50 oxy-acetylene welds and 67.50 arc welds. Standard deviations of 14.05, 261.46 and 550.94 were obtained for total metal jobs, total oxy-acetylene welds and total arc welds respectively.

Table 9. Raw data analysis of metal jobs, oxy-acetylene and arc welds completed prior to taking Agricultural Mechanics 254.

Job	Mean	Median	S.D.
A. Metal jobs			
Tool gages	0.18	0.08	0.04
Hitchpin	0.57	0.12	1.53
Cold chisels	0.29	0.13	0.85
Eye bolts	0.48	0.08	3.33
Twist drills	4.39	0.26	12.00
Total metal jobs	6.17	0.40	14.05
B. Oxy-acetylene welds			
Corner weld	6.57	0.30	36.68
Fusion butt weld	8.16	0.30	38.28
Braze butt	7.62	0.40	37.45
Braze T-fillet	6.42	0.25	36.72
O-A straight cut	23.31	4.17	49.38
O-A bevel cut	8.05	0.25	38.31
O-A hole	11.08	0.40	41.77
Total O-A welds	70.85	12.50	261.46
C. Arc welds			
E 6011 beads	30.08	5.50	72.42
E 6011 butt	25.99	3.79	89.22
E 6011 lap	18.64	0.64	66.80
E 6011 T-fillet	16.09	0.41	69.37
E 6011 trophy	0.59	0.08	2.31
E 6013 beads	55.42	10.10	124.86
E 6013 butt	40.36	5.83	111.00
E 6013 lap	27.29	4.65	84.60
E 6013 T-fillet	25.09	2.36	89.16
E 6013 trophy	3.87	0.10	36.15
Total arc welds	239.93	67.50	550.94

The four dependent variables in the study were: (1) total laboratory points, (2) total lecture points, (3) total course points and (4) mechanical aptitude test score. Illustrated in Table 10 are the means and standard deviations of four dependent variables by quarter of instruction.

Winter quarter students had higher means in total laboratory (302.97), total lecture (248.40) and total course points (551.37), compared to fall quarter students which averaged 295.25 points in the laboratory, 240.61 points in lecture and 536.26 points in the overall course. Students enrolled in Agricultural Mechanics 254 during the winter quarter had lower standard deviations in laboratory (18.32), lecture (16.28) and course (28.10) compared to fall quarter students which had respective standard deviations of 21.74, 20.67 and 34.19 in laboratory, lecture and total course points.

Table 10. Mean scores and standard deviations of dependent variables by quarter of instruction.

Quarter	Aptitude[a]		Laboratory[b]		Lecture[c]		Course[d]	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Fall	0.0	(0.00)	295.25	(21.74)	240.61	(20.67)	536.26	(34.19)
Winter	86.05	(8.19)	302.97	(18.32)	248.40	(16.28)	551.37	(28.10)
Total	86.05	(8.19)	297.71	(20.98)	243.09	(19.68)	541.07	(33.07)

[a]Note: 100 points possible.

[b]Note: 365 points possible.

[c]Note: 300 points possible.

[d]Note: 665 points possible.

A mean of 86.05 and a standard deviation of 8.19 was obtained for mechanical aptitude test scores. Values were obtained only for winter quarter students because copies of the test were not available for fall quarter.

Statistical Analysis and Hypothesis Testing

Correlation analysis

The four dependent variables and 19 selected independent variables were arranged in a correlation matrix. Coefficients of correlation were calculated and are listed in Table 11. Significant differences were obtained at the 0.5 and 0.1 - .05 and .01 level for a number of the variables. Mechanical aptitude test score had an N of 65 while the rest of the variables had an N of 204.

A coefficient of .16 significant at the .05 level, was obtained between laboratory performance and student rating of Agricultural Mechanics 254. A significant coefficient of .16 was found to exist between laboratory performance and previous tool experience. Laboratory performance and weeks of high school arc welding instruction yielded a significant coefficient of .15. Coefficients of correlation which reached the one percent level of significance when the student's laboratory score was compared to the following variables were: the number of home arc welders (32); lecture score (.32); and course score (.83). A highly significant coefficient of .79 was yielded between course score and lecture score. When mechanical aptitude scores were compared to metal jobs done prior to taking Agricultural Mechanics 254 a significant coefficient of .25 was obtained.

Table 11. Coefficients of correlation for selected variables.

Matrix variable	1	2	3
1. Classification at ISU	1.00		
2. Rank in high school class	.14	1.00	
3. Major	.02	.03	1.00
4. Background	.19**	-.04	.04
5. Age	.76**	.02	.01
6. Semesters of high school vocational agriculture	-.16*	.08	-.29**
7. Semesters of high school industrial arts	-.05	-.03	.17*
8. Semesters of agricultural mechanics at post-secondary	.03	-.11	-.01
9. Weeks of high school agricultural mechanics	-.12	-.08	.09
10. Weeks of high school arc welding	-.16*	-.17*	-.03
11. Weeks of high school oxy-acetylene welding	-.11	-.12	-.10
12. Weeks of high school hot and cold welds	-.03	.02	-.02
13. Arc welders at home	-.04	.05	.09
14. Oxy-acetylene welders at home	-.01	-.02	.04
15. Rating of Agricultural Mechanics 254	-.13	-.14	-.04
16. Total tool experience prior to taking Agricultural Mechanics 254	-.22**	-.07	-.05
17. Total metal jobs prior to taking Agricultural Mechanics 254	.10	-.02	.06
18. Total oxy-acetylene welds prior to taking Agricultural Mechanics 254	.08	-.13	-.01
19. Total arc welds prior to taking Agricultural Mechanics 254	-.02	-.16*	.05
20. Laboratory points	.05	.04	.01
21. Lecture points	.07	.33**	-.04
22. Course points	.07	.21**	-.02
23. Mechanical aptitude test scores	.09	.18	.01

[a]Note: Item 23, N = 65.

*.05 level of significance; N = 204, R=.15: N = 65, R = .25.

**.01 level of significance; N = 204, R = .18; N = 65, R = .28.

4	5	6	7	8	9	10	11
					N = 204[a]		
1.00							
.20**	1.00						
-.19**	-.15*	1.00					
-.03	-.05	-.25**	1.00				
-.05	.01	-.08	.05	1.00			
-.11	-.10	.17*	.65**	.02	1.00		
-.11	-.21**	.24**	.26**	-.02	.51**	1.00	
-.10	-.19**	.21**	.18**	.01	.49**	.84**	1.00
.02	-.07	.06	.24**	.00	.44**	.41**	.51**
-.33**	-.02	.07	.19**	-.03	.19**	.13	.08
-.21**	-.02	.04	.06	-.00	.10	.09	.11
-.04	-.17*	-.01	.05	.10	.06	.10	.03
-.21**	-.17*	.34**	.36**	-.01	.46**	.42**	.40**
-.01	.18**	-.03	.23**	.16*	.16*	.10	.13
-.04	.21**	.03	.25**	-.01	.26**	.12	.13
-.06	.07	.03	.32**	-.01	.24**	.25**	.13
-.10	-.02	-.07	.11	-.04	.07	.15*	.12
-.20**	.03	-.11	.06	.11	-.04	-.03	-.01
-.19**	.00	-.12	.12	.04	.03	.07	.06
.14	.08	-.17	-.01	-.05	-.15	-.22	-.22

Table 11 (Continued)

	12	13	14	15	16	17	18	19
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.	1.00							
13.	.18**	1.00						
14.	.15*	.53	1.00					
15.	.05	.02	-.03	1.00				
16.	.39**	.33**	.26**	.04	1.00			
17.	.13	.18**	.10	-.04	.39**	1.00		
18.	.06	.10	.17*	-.12	.20**	.47**	1.00	
19.	.09	.38**	.18**	-.09	.29**	.42**	.61**	1.00
20.	.07	.22**	.22**	.16*	.16*	.08	.09	.09
21.	.04	.08	-.03	.04	.09	.09	.04	-.07
22.	.06	.21**	.13	.12	.15*	.11	.10	.07
23.	-.20	.06	.16	.14	.02	.25*	.11	-.04

20	21	22	23
1.00			
.32**	1.00		
.83**	.79**	1.00	
.08	.05	.08	1.00

T-tests

Means and standard deviations for the dependent variables of laboratory score, lecture score, course score and mechanical aptitude test score were computed for two groups. Group one represented students who had no experience and group two represents those who had experience in the following areas.

1. Semesters of high school vocational agriculture.
2. Semesters of high school industrial arts.
3. Weeks of high school agricultural mechanics.
4. Weeks of high school arc welding.
5. Weeks of high school oxy-acetylene welding.
6. Weeks of high school hot and cold metals.
7. Number of oxy-acetylene welds completed prior to taking Agricultural Mechanics 254.
8. Number of arc welds completed prior to taking Agricultural Mechanics 254.
9. Number of hot and cold metal jobs completed prior to taking Agricultural Mechanics 254.

Previous tool experience was also divided into two groups. Group one consisted of students who had nine or fewer experiences and group two consisted of those who had ten or more previous experiences. Means and standard deviations were calculated for the four dependent variables. T-tests were calculated on all of the above in order to compare the two groups. If the variances between the two groups proved to be equal, a pooled t-test was selected. If the variances between the two groups were not equal, a separate t-test was used.

Data in Table 12 illustrate the mean dependent variable scores concerning weeks of high school agricultural mechanics training.

Table 12. Mean dependent variable scores concerning weeks of high school agricultural mechanics training.

Variable	Group	N	Mean	S.D.	t-ratio
Laboratory	1	42	292.43	26.31	-1.54
	2	162	299.08	19.22	
Lecture	1	42	242.76	21.67	-0.12
	2	162	243.18	19.20	
Course	1	42	535.43	40.65	-1.06
	2	162	542.53	30.75	
Aptitude	1	8	88.63	7.69	0.95
	2	57	88.68	8.26	

Nonsignificant t-ratios of -1.54, -0.12, -1.06 and 0.95 were calculated for the four dependent measures of laboratory score, lecture score, course score and mechanical aptitude score respectively. Based on these results as shown in Table 12 the first null hypothesis which stated: there is no significant difference in achievement between students who had previous agricultural mechanics instruction and those who did not was not rejected.

Mean dependent variable scores related to semesters of high school vocational agriculture and industrial arts are illustrated in Table 13. No significant difference was found between students who had high school vocational agriculture and those who did not. Further, students who had industrial arts in high school did not perform significantly better than those who did not. Hypothesis two stated: there is no significant difference in

achievement between students who had vocational agriculture in high school and nonvocational agriculture students was not rejected based on non-significant t-ratios for laboratory score (0.81), lecture score (1.75), course score (1.62) and aptitude score (1.85) as found in part A of Table 13.

Table 13. Mean dependent variable scores related to semesters of high school vocational agriculture and industrial arts.

Variable	Group	N	Mean	S.D.	t-ratio
A. Vocational Agriculture					
Laboratory	1	80	299.05	24.05	0.81
	2	124	296.70	18.77	
Lecture	1	80	246.07	19.83	1.75
	2	124	241.17	19.43	
Course	1	80	545.91	36.83	1.62
	2	124	537.95	30.10	
Aptitude	1	29	88.10	7.30	1.85
	2	36	84.39	8.59	
B. Industrial Arts					
Laboratory	1	61	296.49	21.83	-0.54
	2	143	298.23	20.66	
Lecture	1	61	241.57	18.81	-0.72
	2	143	243.47	20.07	
Course	1	61	538.06	34.42	-0.85
	2	143	542.36	32.49	
Aptitude	1	20	83.25	8.22	-1.87
	2	45	87.29	7.95	

Nonsignificant t-ratios of -0.54, -0.72, -0.85 and -1.87 were obtained for the four dependent variables of laboratory, lecture, course and aptitude scores respectively, when industrial arts students and nonindustrial arts were compared. These relationships are illustrated in Table 13 part B. Based on these results, hypothesis three stated: there is no significant difference in achievement between students who had industrial arts in high school and nonindustrial art students was not rejected.

Hypothesis four stated: there is no significant difference in aptitude scores between students who had previous agricultural mechanics instruction and those who did not was not rejected based on a nonsignificant t-ratio of 0.95 for aptitude score as found in Table 12.

Data in Table 14 illustrate the mean dependent variable scores concerning weeks of high school instruction in arc welding, oxy-acetylene welding and hot and cold metals. Part A of Table 14 illustrates nonsignificant t-ratios in laboratory (-1.16), lecture (0.09), course (-0.71) and aptitude score (1.69). Part B of Table 14 indicates nonsignificant t-ratios of -0.65, -0.50, -0.77 and 1.25 respectively for laboratory, lecture, course and aptitude score. Illustrated in Part C of Table 14 are nonsignificant t-ratios for laboratory score (-1.45), lecture score (1-.47), course score (-1.90) and aptitude score (1.07) Based on the data found in parts A, B and C of Table 14 the fifth null hypothesis which stated: there is no significant difference in achievement between students who received instruction in high school in the following areas and those who did not: (1) arc welding, (2) oxy-acetylene welding and cutting and (3) hot and cold metals was not rejected.

Table 14. Mean dependent variable scores concerning weeks of high school instruction in arc welding, oxy-acetylene welding and hot and cold metals.

Variable	Group	N	Mean	S.D.	t-ratio
A. Weeks of arc welding					
Laboratory	1	60	295.06	23.90	-1.16
	2	144	298.82	19.62	
Lecture	1	60	243.28	19.18	0.09
	2	144	243.01	19.95	
Course	1	60	538.52	36.15	-0.71
	2	144	542.14	31.74	
Aptitude	1	18	88.78	6.28	1.69
	2	47	85.00	8.64	
B. Weeks of oxy-acetylene welding					
Laboratory	1	84	296.57	22.44	-0.65
	2	120	298.51	19.95	
Lecture	1	84	242.26	19.93	-0.50
	2	120	243.68	19.56	
Course	1	84	538.95	35.66	-0.77
	2	120	542.56	31.16	
Aptitude	1	28	87.50	7.18	1.25
	2	37	84.95	8.81	
C. Weeks of hot and cold metals					
Laboratory	1	122	295.97	21.40	-1.45
	2	82	300.30	20.17	
Lecture	1	122	241.44	20.03	-1.47
	2	82	245.55	19.01	
Course	1	122	537.49	34.70	-1.90
	2	82	546.40	29.85	
Aptitude	1	37	87.05	6.25	1.07
	2	28	84.71	10.18	

Table 15 illustrates the mean dependent variable scores concerning number of arc welds, oxy-acetylene welds and metal jobs done prior to taking Agricultural Mechanics 254. Data in Part A of Table 15 illustrates a nonsignificant t-ratio of -1.21 for lecture score and 0.26 for aptitude score. Negative significant t-values of -2.44 and -2.14 were observed for laboratory and course score respectively.

Information in Part B of Table 15 illustrates a highly negative significant t-ratio (-3.15) for laboratory score. A negative significant t-ratio (-2.58) was also found for course score. Nonsignificant t-ratios of -0.46 and -0.60 were calculated for lecture score and aptitude score respectively. Hypothesis six, there is no significant difference in achievement between students who had completed one or more welding jobs in arc welding and oxy-acetylene welding and cutting and those who had completed none was rejected for laboratory and course scores based on data illustrated in Parts A and B of Table 15. Those sections of hypothesis six dealing with lecture and aptitude scores were not rejected based on the nonsignificant t-values.

A negative significant t-value of -2.11 was obtained for course score in Part C of Table 15. Nonsignificant t-values were calculated for laboratory (-1.87), lecture (-1.28) and aptitude scores (-0.38). Based on data found in Part C of Table 15 hypothesis seven, there is no significant difference in achievement between students who had completed one or more metal jobs and those who had completed none was not rejected for laboratory, lecture and aptitude scores. The section of hypothesis seven dealing with

course score was rejected as a significant negative t-value of -2.11 was produced.

Table 15. Mean dependent variable scores concerning previous number of arc welds, oxy-acetylene welds and metal jobs.

Variable	Group	N	Mean	S.D.	t-ratio
A. Oxy-acetylene welding jobs					
Laboratory	1	71	292.85	23.27	-2.44*
	2	133	300.30	19.25	
Lecture	1	71	240.82	21.90	-1.21
	2	133	244.31	18.36	
Course	1	71	533.82	38.26	-2.14*
	2	133	544.95	29.32	
Aptitude	1	21	86.43	7.42	0.26
	2	44	85.86	8.60	
B. Arc welding jobs					
Laboratory	1	44	287.95	24.21	-3.15**
	2	160	300.39	19.23	
Lecture	1	44	241.88	20.37	-0.46
	2	160	243.43	19.54	
Course	1	44	529.84	36.25	-2.58*
	2	160	544.16	31.53	
Aptitude	1	7	84.29	9.58	-0.60
	2	58	86.25	8.01	
C. Metal jobs					
Laboratory	1	113	295.33	22.91	-1.87
	2	91	300.67	17.98	
Lecture	1	113	241.52	19.93	-1.28
	2	91	245.05	19.30	
Course	1	113	536.84	35.90	-2.11*
	2	91	546.33	28.46	
Aptitude	1	32	85.66	6.65	-0.38
	2	33	86.43	9.54	

*.05 level of significance.

**.01 level of significance.

Mean dependent variable scores concerning previous tool experience are illustrated in Table 16. Nonsignificant t-ratios of -1.24, -0.74, -1.11 and 0.05 were calculated for laboratory, lecture, course and aptitude scores respectively. Hypothesis eight, there is no significant difference in achievement between students who had ten or more experiences with the following tools and those who had nine or fewer experiences: (1) metric micrometer, (2) metric vernier caliper, (3) english micrometer, (4) english vernier caliper, (5) tap and die set, (6) tool grinder, (7) power hacksaw, (8) hand hacksaw, (9) forge and anvil, (10) arc welder, (11) oxy-acetylene welder (12) drill press, (13) oxy-acetylene cutting torch and (14) metal working hand tools (file, scribe, center punch, ballpeen hammer) was not rejected.

Table 16. Mean dependent variable scores concerning previous tool experience.

Variable	Group	N	Mean	S.D.	t-ratio
Laboratory	1	39	293.97	23.00	-1.24
	2	165	298.59	20.45	
Lecture	1	39	241.00	22.51	-0.74
	2	165	243.58	19.00	
Course	1	39	534.97	39.71	-1.11
	2	165	542.52	31.23	
Aptitude	1	14	86.14	7.86	0.05
	2	51	86.02	8.35	

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Statement of the Problem

Vocational education in the past fifteen years has undergone much change in order to meet student needs. The 1963 Vocational Education Act and the 1968 and 1976 Vocational Amendments have been the primary catalysts. Legislation regarding vocational education has brought renewed interest and financial support to vocational education throughout the public school system. More emphasis is being placed on technical skills that can be applied directly to a specific job or occupation.

Purpose of the Study

The purpose of this study was to determine the effects of previous training in agricultural mechanics upon achievement of students enrolled in Agricultural Mechanics 254. A second purpose was to determine factors that effect performance in Agricultural Mechanics 254, a basic metals and welding course at Iowa State University.

Procedure

Students enrolled in Agricultural Mechanics 254 during fall and winter quarters of 1977-78 at Iowa State University comprised the research sample of 204. Ten laboratory sections of Agricultural Mechanics 254 were taught during fall quarter and six sections were taught during winter quarter with seven instructors involved in the study. Data were collected from three sources, those being: (1) a survey (Appendix) administered during the final week of each quarter, (2) a mechanical aptitude test given during the first

week of winter quarter and (3) laboratory, lecture and course totals obtained from each instructor involved in the study.

Summary of Findings

Freshmen and sophomore students comprised 82 percent of the sample with most students enrolled in the farm operations (50.5 percent) or agricultural education (23.0 percent) curriculums. Data gathered from the student survey indicated the following information:

1. The mean number of semesters of high school vocational agricultural and industrial arts completed were 3.73, 2.72 respectively with a range of 12 semesters.
2. Students received an average of 41.45 weeks of high school instruction in agricultural mechanics, 6.28 weeks in arc welding, 3.79 weeks in oxy-acetylene welding and 4.11 weeks in hot and cold metals. The range for weeks of high school instruction received in agricultural mechanics was 270, for arc welding 54, oxy-acetylene welding 45 and hot and cold metals 99 weeks.
3. A mean of 15.70 was calculated for previous total tool experience with a range of 38.
4. Means and medians were calculated for total number metal jobs (6.18, 0.40), oxy-acetylene welds (70.85, 12.50), and arc welds (293.93, 67.50) completed prior to taking Agricultural Mechanics 254. Respective values of 99, 3507 and 5392 were obtained when calculating the range

for total metal jobs, oxy-acetylene welds and arc welds done prior to taking Agricultural Mechanics 254.

5. Average laboratory, lecture and course points were 297.71, 243.09 and 541.07 out of a possible 365, 300 and 665 points respectively. Those students who took the mechanical aptitude test during winter quarter had an average score of 86.05

Nonsignificant t-values were produced between students who had previous agricultural mechanics instruction and those who did not and on this basis hypothesis one, there is no significant difference in achievement between students who had previous agricultural mechanics instruction and those who did not was not rejected.

Hypothesis two, there is no significant difference in achievement between students who had vocational agriculture in high school and nonvocational agriculture students was not rejected based on the nonsignificant t-values that were produced when nonvocational agriculture and vocational agriculture students were compared.

Hypothesis three, there is no significant difference in achievement between students who had industrial arts in high school and nonindustrial arts students was not rejected based on nonsignificant t-values.

Nonsignificant t-values were calculated for mechanical aptitude test scores between students who had previous agricultural mechanics instruction and those who did not. On this basis hypothesis four, there is no signif-

icant difference in aptitude scores between students who had previous agricultural mechanics instruction and those who did not was not rejected.

Based on nonsignificant t-values hyposthesis five, there is no significant difference in achievement between students who received instruction in high school in the following areas and those who did not: (1) arc welding, (2) oxy-acetylene welding and cutting and (3) hot and cold metals was not rejected.

Hypothesis six which stated: there is no significant difference in achievement between students who had completed one or more welding jobs in arc welding and oxy-acetylene welding and cutting and those who had completed none, for laboratory and course scores was rejected. Students who had previous experience in arc and oxy-acetylene welding performed significantly better in the laboratory and overall course than those who had no previous experience. Sections of hypothesis six dealing with lecture and aptitude scores were not rejected as nonsignificant t-values were produced when the two groups were compared.

Hypothesis seven, there is no significant difference in achievement between students who had completed one or more metal jobs and those who had completed none was not rejected for those parts dealing with laboratory, lecture and aptitude scores based on nonsignificant t-values. The section of hypothesis seven dealing with course score was rejected. Students who had previous experience in metals performed siginificantly better in the overall course than those who did not.

Based on data revealing nonsignificant t-values hypothesis eight,

there is no significant difference in achievement between students who had ten or more experiences with the following tools and those who had nine or fewer experiences: (1) metric micrometer, (2) metric vernier caliper, (3) english micrometer, (4) english vernier caliper, (5) tap and die set, (5) tool grinder, (7) power hacksaw, (8) hand hacksaw, (9) forge and anvil, (10) arc welder, (11) oxy-acetylene welder, (12) drill press, (13) oxy-acetylene cutting torch and (14) metal working hand tools (file, scribe, center punch, ballpeen hammer) was not rejected.

Conclusions

Based on the findings of this study, the following conclusions were drawn:

1. Students who had received high school instruction in vocational agriculture and industrial arts did not perform significantly better than those who did not. However, students who had high school vocational agriculture received lower laboratory, lecture, course and aptitude scores compared to nonvocational agriculture students. Laboratory, lecture, course and aptitude scores were higher for students who had received high school instruction in industrial arts compared to those who did not. The author believes no significant differences were obtained for the following reasons:
   A. Groups being compared where not of equal size.
   B. Students who had received high school instruction in vocational agriculture or industrial arts may have enrolled in Agricultural Mechanics 254 with the idea that they could not gain much from the course since they had received previous instruction in vocational

agriculture or industrial arts.

C. High school and junior high school instructors may be placing to much emphasis on project development and not enough on skill development in the area of agricultural mechanics.

2. Students who had received high school instruction in agricultural mechanics, oxy-acetylene welding, arc welding and hot and cold metals did not perform significantly better than those who did not, but did score just as high or higher in laboratory, lecture and total course points. The author believes no significant differences were obtained for the following reasons:

   A. Groups being compared were not of equal size.
   B. Students who did receive high school instruction in the areas stated above, may of felt Agricultural Mechanics 254 was a repeat of what they had in high school. Therefore, not putting forth their maximum effort.
   C. Students who did not receive previous instruction in agricultural mechanics, oxy-acetylene welding, arc welding and hot and cold metals should not be severly handicapped from a subject matter standpoint compared to those students who had received previous instruction.

3. Students who had previous experience in arc and oxy-acetylene welding jobs performed significantly better in the laboratory and overall course than those who had no previous welding experience. However, students who had previous experience in metal activities performed significantly better in the overall course compared to students who did not. The author believes significant differences were obtained for the following reasons:

A. Students who had performed various arc and oxy-acetylene welds should have a definite advantage over students who had no previous experience

B. Students who perform well in laboratory usually perform well in lecture and the overall course.

4. Mechanical aptitude test scores were higher for students who had previous agricultural mechanics instruction compared to those who did not. However, no significant difference was obtained. The author believes no significant difference was found for the following reasons:

A. Groups being compared were not of equal size.

B. A test designed more in the area of metals and welding may be better suited for Agricultural Mechanics 254 than a general mechanical aptitude test.

Recommendations

Based on the findings of this study, the author recommends duplicating the study with a larger number of experimental units taking the mechanical aptitude test.

It is recommended that a similar study be conducted but limit the number of jobs compared, keeping them more in line with the jobs most commonly required in a high school welding and metals unit.

The author further recommends that a study be conducted in the area of students' attitude toward agricultural mechanics, since those students who had received high school instruction in vocational agriculture, industrial arts and agricultural mechanics did not perform significantly better than those who had not had previous instruction in these areas.

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APPENDIX

Iowa State University of Science and Technology Ames, Iowa 50011

Name: _____

DIRECTIONS: Circle the response that best fits your situation. Please answer all of the following questions.

1. Classification at ISU

   1. freshman
   2. sophomore
   3. junior
   4. senior

2. Rank in high school class

   1. bottom ¼
   2. third ¼
   3. second ¼
   4. top ¼

3. Major

   1. Agricultural Education
   2. Agricultural Business
   3. Agricultural Mechanics
   4. Farm Operations
   5. Agronomy
   6. Animal Science
   7. Dairy Industry
   8. Other_____

4. Background

   1. farm background
   2. farm related
   3. non-farm

DIRECTIONS: Answer each of the following questions by putting your answer in the appropiate space provided. (Note: if you were taking two industrial arts classes at the same time, count each individual class as one semester.)

5. _____Age

6. _____Semesters of high school vocational agriculture completed.

7. _____Semesters of high school industrial arts completed.

8. _____Semesters of agricultural mechanics training received at a post-secondary institution outside of Iowa State University.

9. _____Weeks of agricultural mechanics training received in high school.

10. _____Total weeks of arc welding instruction received in high school, including vo-ag and industrial arts.

11. _____Total weeks of oxy-acetylene instruction received in high school, including vo-ag and industrial arts.

12. _____Total weeks of hot and cold metal instruction received in high school, including vo-ag and industrial arts.

13. _____Number of arc welders at home.

14. _____ Number of oxy-acetylene welders at your home.

15. _____ Number of agricultural mechanics contests participated in. Include only district and state contests.

DIRECTIONS: In responding to the following question below, use the following scale:

1 2 3 4 5 6 7 8 9
poor average excellent

16. _____ Rate how you feel agricultural mechanics 254 compares to other courses that you have taken at Iowa State University.

DIRECTIONS: Indicate in the appropriate column with an (X) where you have used the following equipment prior to courses at ISU. Leave all spaces blank if you have not used the equipment. You may check more than one column if necessary.

17. Experience with	Vocational Ag Mechanics Lab	Industrial Arts Lab	Home, farm or Other
example: BEVEL PROTRACTOR	X		X
metric micrometer			
metric vernier caliper			
english micrometer			
english vernier caliper			
tap and die set			
tool grinder			
power hacksaw			
hand hacksaw			
forge and anvil			
arc welder			
oxy-acetylene welder			
operating and adjusting drill press			
oxy-acetylene cutting torch			
metal working hand tools: (file, scribe, center punch, ball peen hammer)			

PART 3

- DIRECTIONS: Indicate in the appropriate column where and how many of the following jobs were completed prior to taking agricultural mechanics 254. Leave the column blank if you have not performed any of the following jobs. You may need to use more then one column if necessary.

18. METALS

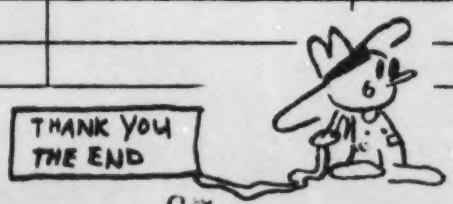
	Vocational Ag Mechanics lab	Industrial Arts lab	Home, farm or other
example: GATE HOOK	4		
tool gages made prior to ag mech. 254			
hitchpins			
cold chisels			
eyebolts			
twist drills sharpened			

19. OXY-ACETYLENE

corner weld			
fusion butt weld with filler rod			
braze butt			
braze T-fillet			
O-A straight cut			
O-A bevel cut			
O-A hole			

20. ARC WELDING

E6011 beads			
E6011 butt			
E6011 lap			
E6011 T-fillet			
E6011 trophy			
E6013 beads			
E6013 butt			
E6013 lap			
E6013 T-fillet			
E6013 trophy			



AG MECH 254
METAL EVALUATION SHEET

DRILL BIT	POINTS POSSIBLE
1. Cutting lips 59°	5
2. Cutting lips equal length	5
3. Clearance angle 12-15°	4
4. Correct angle between dead center and cutting lip (120 - 125°)	2
5. Smoothness of grind	3
6. Spiral chips	1
	20

HITCHPIN	
1. Holes centered and aligned	5
2. Hole placement	3
3. Weld on handle	4
4. Weld on washer	5
5. Washer square on pin	3
6. Handle centered	3
7. Round handle	3
8. Tapered area smooth	2
9. Length of pin	2
	30

COLD CHISEL	
1. Correct tip hardness	10
2. Cutting edge 60° - straight and even	4
3. Overall length 5½"	4
4. Cutting edge 5/8" x 3/16"	4
5. Camfer dimensions	2
6. True taper	3
7. Overall appearance	3
	30

EYE BOLT	
1. Eye centered	5
2. Eye 1" diameter	5
3. Length - 5"	4
4. Round and free of hammer marks	6
5. Correct thread cutting and length	4
6. Nut 1" x 1"	2
7. Nut hole centered	2
8. Nut corner beveled	2
	30

TOOL GAGE	
1. Length	2
2. Width of narrow end	2
3. Width of wide end	2
4. V for chisel 60°	3
5. 59° angle	4
6. 12° angle	4
7. Accuracy of scale	4
8. Beveled corners	2
9. Finish	2
	25

AG MECH 254
METAL EXAM

True or False

1. Cast iron generally has lower tensil strength as compared to steel.
2. A ferrous metal is made up of iron and carbon.
3. A ferrous metal that contains less than 1.7% carbon is classified as cast iron.
4. Rests on grinding wheels should be 3/8" from the stone.
5. A two inch micrometer reads from 0-2".
6. Stainless steel responds well to heat treatment.
7. Coke is a high carbon steel.
8. Rimmed steel has a higher percent carbon than killed steel.
9. Cold rolling makes metal ductile and soft.
10. Steel, when heated to transformation temperature forms large grains of austenite.
11. Non-ferrous metals can easily be cut with an oxy-acetylene torch.
12. 100 percent full thread is the most common type of cut.
13. White cast iron is very ductile.
14. Cast iron is a non-ferrous metal.
15. A bessemer converter is used in producing pig iron.
16. Iron and carbon = steel or cast iron.
17. Toughness is the inability of a metal to absorb repeated impact.
18. High speed steel and high carbon steel are the same.
19. Brass is a non-ferrous metal and is an alloy of copper and nickel.
20. Majority of tools today are produced from low carbon steel.
21. The cape chisel is used to cut round grooves.
22. A pilot hole (small hole used to guide final cut) should be used for any size in excess of a 3/8" hole.
23. As a rule of thumb, slower drilling speeds are needed on low carbon metals when drilling big holes as compared to high carbon steels.

24. Normalizing is a process used to prepare steel for further treatment by cooling metal slowly in asbestos after heating above critical temperature.

25. A 3/8" stock requires a 3/8" die.

26. Gear teeth and crankshafts are surfaced hardened by a processs known as flame hardening.

27. The hitchpin was surface hardened by a process known as liquid carburizing.

Multiple Choice - circle the one best answer

28. A 50mm metric micrometer measures from:

a) o-25mm b) 25-50mm c) 0-50mm d) 50-75mm

29. Metallurgy involves:

a) extracting metal from ore
b) refining to pure metals
c) forming useable shapes
d) all of the above
e) none of the above

30. $\frac{\text{Brinnel}}{2} \times 1000 =$

a) tensil strength
b) compressive strength
c) ductility
d) all of these
e) none of these

31. In quenching to harden steels _____ will give severe, cooling:

a) cold water b) warm water c) brine d) all of these
e) none of these

32. Carburizing is one of the ways to surface harden a material. It works best on:

a) high carbon steel
b) medium carbon steel
c) low carbon steel
d) (a) and (b)

33. Heat treatment of metals works best on:

a) high carbon steel
b) stainless steel
c) low carbon steel
d) all of these

34. Annealing:

a) results in softer steel
b) reduces stress
c) increases the hardness of steel
d) (a) and (b)
e) all of these

35. One full turn of the thimble on an english micrometer is equal to:

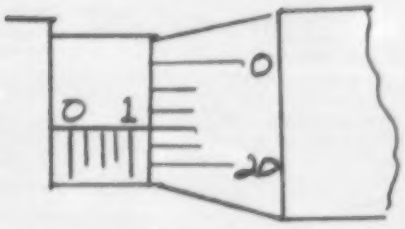
a) .015" b) .020" c) .025" d) .001"

36. One full turn of the thimble on a metric micrometer is equal to:

a) .0005mm b) .005mm c) .05mm d) .5mm

37. Read the following micrometer:

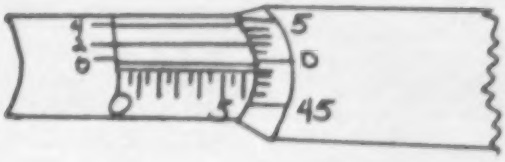
2" micrometer



a) 2.122"
b) 2.147"
c) 1.147"
d) 1.122"

38. Read the following micrometer

50mm micrometer



a) 56.492mm
b) 31.492mm
c) 50.442mm
d) 31.494mm

39 The basic raw materials that go into making pig iron are:

a) iron ore
b) coke
c) limestone
d) air
e) all of the above

40. Which of the following methods produces the majority of our steel today:

a) open hearth process
b) Bessemer process
c) electric furnace
d) basic oxygen

41. Hot rolled steel has:

a) a scaled covered surface
b) rounded edges
c) sharp edges
d) size tolerance of .001"
e) (a) and (b)

42. Cold rolled steel:

a) smooth shiny surface
b) sharp edges
c) a wide size tolerance
d) rounded edges
e) (a) and (b)

43. The depth of the case acquired when carburizing a material depends on:

a) temperature
b) time
c) type of metal
d) all of the above
e) none of the above

44. "Rimmed steel" is caused by:

a) hot rolling
b) basic oxygen process
c) O_2 bubbles removing carbon
d) addition of silicon

45. Carbon steels have a(an)_____ centered crystal lattice at room temperature and a(an) _____ centered lattice above critical temperature.

a) face, body
b) self, body
c) body, face
d) id, ego
e) none of the above

46. 1095 steel is _____ carbon:

a) medium
b) high
c) very high
d) high speed

47. As carbon content increases:

a) weldability increases
b) ductility increases
c) response to heat treatment increases
d) none of the above
e) all of the above

48. Cold rolling makes steel:

a) hard
b) soft
c) malleable
d) ductile

49. Transformation temperature of steel is:

a) 1000°F
b) 1200°F
c) 1330°F
d) 1500°F

50. Vitrified bonding types of grinding wheels are preferred for:

a) general grinding
b) finish work
c) high temperature work
d) cut off work
e) none of the above

51. Hardenability and weldability are <u>not</u> influenced by which of the following:

a) cooling cycle
b) carbon content
c) speed of cooling
d) alloying metals
e) heating cycle

52. Undulated, alternate and raker are types of:

a) hammers
b) files
c) saw blades
d) grinders

53. Files are classified by:

a) type and coarseness of cut, length and shape
b) set, teeth per inch, length and width
c) size, flute, web
d) thickness, weight and height

54. Lip clearance on sharpening a drill bit is:

a) 59^{o}
b) 30^{o}
c) 60^{o}
d) $12\text{-}15^{o}$

55. When the cold chisel was heated up to the transformation temperature over on the forge, the grain structure became:

a) martensite
b) pearlite
c) feritte
d) austenite

56. When you took your cold chisel out of the furnace and stuck the tip in the water, you made the tip:

a) more malleable
b) more ductile
c) tougher
d) harder

57. Which of the following is <u>not</u> a method of surface hardening:

a) flame-hardening
b) tempering
c) induction hardening
d) liquid carburizing

58. As carbon content of steel increases cutting speed of a drill bit:

a) stays constant regardless of the carbon content
b) increases
c) decreases
d) none of the above

59. Hardening and tempering consists of:

a) heating the steel above the critical range
b) quenching it
c) reheating it to a point below the critical range
d) all of the above
e) none of the above

60. Your hitchpin was surfaced hardened by:

a) flame hardening
b) liquid carburizing
c) induction hardening
d) tempering

61. In spark testing, as carbon content increases the number of explosiions or sparks:

a) decreases
b) increases
c) doesn't change
d) none of the above

62. In producing pig iron limestone:

a) increases the oxygen content
b) decreases the carbon content
c) combines with the impurities and floats them to the top
d) all of the above

63. Taps are used to cut:

a) external threads
b) internal threads
c) (a) and (b)
d) none of the above

64. A hacksaw blade should have _____ teeth in contact with metal at all times.

a) 1
b) 2
c) 3
d) 4

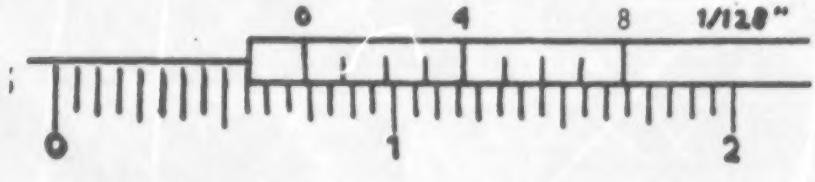
65. Wrought iron is:

a) a high carbon steel produced from the Bessemer process
b) a low carbon steel produced from the Bessemer process
c) hard and brittle
d) hard to weld

66. The ratchet stop on a micrometer allows:

a) consistant tension
b) rapid movemert of the spindle
c) all of the above
d) none of the above

67. Read the following vernier caliper



a) 88/128
b) 94/128
c) 1 88/128
d) none of the above

Matching (answers may be used more than once)

68. _____ Highly ductile
69. _____ White color when fractured
70. _____ Contains graphite
71. _____ Produced by annealing white cast iron
72. _____ Contains a "skin" of steel
73. _____ High wear resistance
74. _____ Most common

a) gray cast iron
b) white cast iron
c) malleable cast iron
d) nodular cast iron

75. _____ Alloy Steel
76. _____ Ability to resist penetration
77. _____ Ability to absorb repeated abuse

a) toughness
b) stainless steel
c) hardness
d) coke
e) none of the above

78. _____ Easily shaped
79. _____ Small grain structure
80. _____ Inability to resist impact

a) austenite
b) ductility
c) ferrite
d) brittleness
e) none of the above

AG MECH 254 TEST
Oxyacetylene Welding

True or False

1. Acetylene impurities can be toxic.
2. The first step in braze welding cast iron is to position the parts by tack welding.
3. In a two stage regulator as tank pressure decreases working pressure decreases.
4. Oxygen is a colorless, ordorless and tasteless gas.
5. Oxygen is most commonly produced by the electrolytic method.
6. Acetylene pressure above 15 lbs, are not hazardous when cutting.
7. Soap may be used on connections when testing for leaks.
8. A full tank of oxygen contains 244 cubic feet of oxygen and is stored at 2200 psi.
9. In fusion welding the backhand method and forehand method give equal pentration.
10. Oxygen and acetylene regulators may be placed on the incorrect cylinder and still perform satisfactorily.
11. In doing fusion welding the tip should be slanted at 45^{o} and a work angle of 90^{o}.
12. A full cylinder of acetylene is stored at 250 psi.
13. Correct eye protection for welding is a 4 or 5 filtered lens.
14. To keep acetylene under pressure it is packed with a porous material asbestos and balsa wood which contain acetone.
15. Oxygen burns by itself.
16. One should make sure that the adjusting screw is turned in before turning the cylinder on.
17. Damaged hoses should only be repaired with new hoses or the appropriate connections.
18. Acetylene is a man made gas, has a very distinctive odor and is lighter than air.
19. Acetylene cylinder valves should be opened ½ to 3/4 of a turn.
20. The oxygen tank valve is a double seated type.

MULTIPLE CHOICE (fill in the correct blank)

21. A carburizing flame with a 3x flame has an acetylene feather equal in size to

a) 6 times the length the size of the inner cone
b) 1/3 the length of the inner cone
c) the outer envelope
d) 3 times the length the size of the inner cone

22. The affect of a neutral flame on mild steel causes:

a) much sparking
b) metal to boil
c) it to flow smoothly with very few sparks
d) b&c

23. More _____ is required when using mapp gas.

a) acetylene
b) oxygen
c) propane
d) none of these

24. Oxygen cylinders come in:

a) blue
b) green
c) red
d) none of these

25. Which of the following is not advantages of fusion welding:

a) easily machined
b) withstand high temperatures
c) high tensile strength
b) color of completed weld

26. The formula for oxyacetylene combustion is:

a) $CaC_2 + O_2 = H_2 + CO_2 + heat$
b) $2\ C_2H_2 + 5\ O_2 = 2H_2O + 4CO_2 + heat$
c) $C_2H_2 + O_2 = H + CO_2 + heat$
d) none of these

27. Acetylene cylinders come in:

a) green
b) blue
c) red
d) none of these

28. Flux:

a) is something you eat
b) mechanically cleans the base metal
c) chemically cleans the base metal
d) need not be used in braze welding

29. Types of welding flames listed in order from least to highest in temperature:

a) carburizing, neutral, oxidizing
b) oxidizing, neutral, carburizing
c) neutral, carburizing, oxidizing
d) carburizing, oxidizing, neutral

30. Too much slag on an oxyacetylene cut indicates:

a) to much heat
b) tip to far away from work
c) travel to slow
d) a & c

31. Hose connections for oxygen are:

a) left handed
b) right handed
c) both
d) none of these

32. The _____ rod is composed of 60% copper and 40% zinc.

a) braze
b) silverbrazing
c) steel filler
d) none of these

33. Two techniques of welding are:

a) forehand and backhand
b) vertical and orifice
c) brazing and fusion welding
d) backfire and flashback

34. Backfires are caused by:

a) to fast of speed
b) dirty tips
c) improper gas oressure
d) b & c

35. Which of the following is <u>not</u> correct when handling cylinders:

a) lift by protective cap
b) keep free of grease and oil
c) store separate
d) secure upright

36. The major steps involved in braze welding or brazing are:

a) tin the surface
b) chemically clean
c) mechanically clean
d) preheating the base metal
e) all of these

37. Hose connections for acetylene are:

a) left handed
b) right handed
c) both
d) none of these

38. In braze welding the base metal:

a) melts and fuses with the filler rod
b) does not need to be clean
c) does not melt
d) b & c

39. In heat control which of the following is not immediately available to the operator:

a) distance from work
b) angle of tip
c) speed
d) flame type

40. The neutral flame is approximately:

a) 6500
b) 6000
c) 6800
d) 5500°F

41. In selecting a filler rod for fusion welding, generally:

a) filler rod should be 4 times the diameter of the thickness of the base metal
b) filler rod should be 2 times the diameter of the thickness ofthe base metal
c) filler rod should be the same diameter of the thickness of the base metal
d) filler rod should be 3 times the diameter of the thickness of the base metal

42. Joint preparation for braze welding should begin on anything larger than:

a) 5/16
b) 1/4
c) 1/8
d) 3/16

43. _____ is a stable form of acetylene:

a) mapp
b) butane
c) oxygen
d) propane

44. Fusion welding is fusing of base metal by:

a) melting them together with or without a filler rod
b) brazing
c) capillary action
d) none of these

45. The inner cone when welding should be_____" from the molten pool when welding:

a) 1/2
b) 1/8
c) 1/16
d) 1/4

MATCHING(list in order the procedure for lighting the portable O-A unit)

46. _____ a) readjust gages and flame
47. _____ b) open acetylene valve and light
48. _____ c) adjust gages to approximate working pressure
49. _____ d) add oxygen to the desired flame type
50. _____ e) turn on oxygen and acetylene cylinders

List in order the procedure to use in setting up the O-A unit:

51. _____ a) crack valves
52. _____ b) secure cylinder
53. _____ c) blow out hoses
54. _____ d) connect hoses to regulator
55. _____ e) attach regulators

56. _____ a) attach blowpipe to hoses
57. _____ b) blow out dust and dirt from blowpipe
58. _____ c) check for leaks
59. _____ d) select welding tip and cutting head
60. _____ e) turn on O-A unit (but do not light)

FILL IN THE BLANKS (write answers on back of answer sheet)

61. Acetone is a chemical that can absorb____ times its own volume of acetylene without changing the nature of acetylene.

62. The two types of regulators are (a) _____ and (b)_____.

63. List the two ways in which a blowpipe can be held properly.
a)_____ b) _____

64. In fusion welding, tack welds should be placed at both ends when welding two pieces together and/or every _____.

65. The _____ method of producing oxygen is the most expensive and the least common.

66. The _____ method of producing oxygen consist of separating the various gases in air by cooling them to a very low temperature.

67. Acetylene is produced from a)_____ and b) _____.

68. The_____ pressure type torch delivers equal volumes of acetylene and oxygen to the mixing chamber.

69. The oxyacetylene cutting torch tip contains a)_____ orficies and a(an) b) _____.

70. The melting temperature of steel is _____.

71. List 4 of the 6 methods or ways of controlling heat.
a) _____ c) _____
b) _____ d) _____

61. _____

62. a) _____

b) _____

63. a) _____

b) _____

64. _____

65. _____

66. _____

67. a) _____

b) _____

68. _____

69. a) _____

b) _____

70. _____

71. a) _____

b) _____

c) _____

d) _____

DIRECTIONS: Identify the following parts and be specific in your answer. For example, do not say hose, say oxygen hose.

A. _____

B. _____

C. _____

D. _____

E. _____

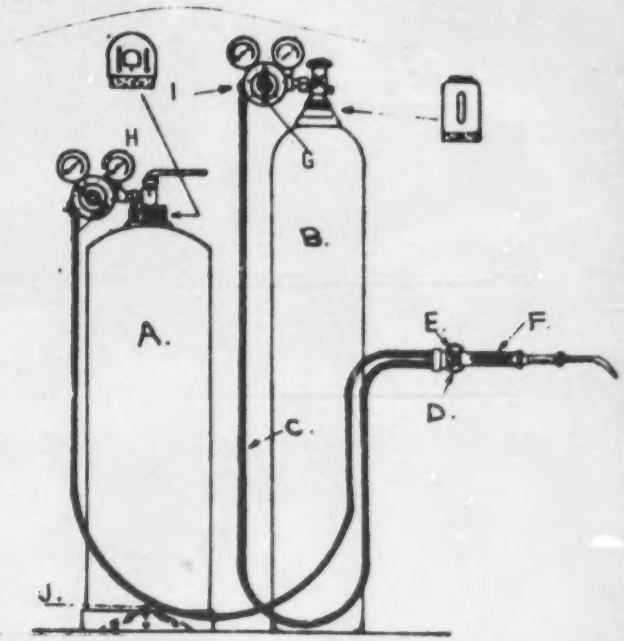
F. _____

G. _____

H. _____

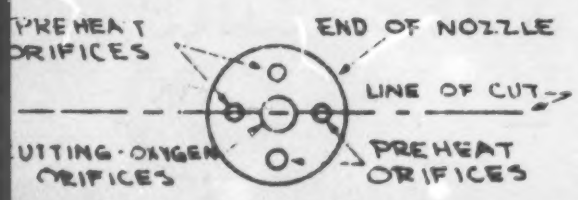
I. _____

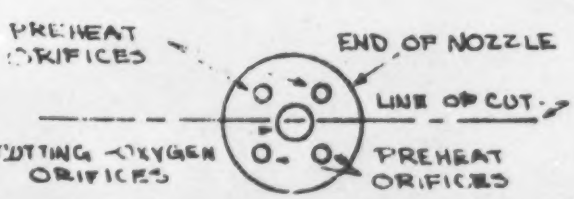
J. _____



Identify that type of cut each nozzle arrangement would be for?

_____ _____





AG MECH 254
Arc Welding Exam

True or False

1. The toe of a weld refers to the width of the bead.
2. The first two digits of an E6011 represents the minimum tensile strength of the deposited weld metal and is expressed in hundreds of pounds per square inch.
3. An AWS6011 is a NEMA Brown spot rod.
4. An AWS6013 is an NEMA Blue spot rod.
5. The E6011 electrode can be used for all welding positions.
6. Electrons flow from positive to negative.
7. Finger nailing is an uneven burning of the flux coating which causes erratic arc behavior.
8. Arc blow may occur when using AC current.
9. The main difference between an E6011 and an E6013 is in the flux coating
10. Amperage determines heat.
11. An increase in arc length will decrease your actual amperage.
12. The width of a bead is primarily influenced by amperage.
13. An E6011 electrode can not run on DC current.
14. DC straight polarity has an inherently forceful arc.
15. The lense for an AC welding helmet should be at least a shade #10 lense.
16. Generally, a DC rectifier welder has a soft arc.
17. Argon and Helium are gases that can be used for MIG welding.
18. Induction contributes to power loss in transformer welders.
19. AC arc welders are built to take 25% more than their rated output.
20. Bead diameter should be the same diameter as the electrode wire.
21. An E6011 electrode is usually set at a lower amperage setting then an E6013 when welding the same thickness of metal.
22. A DC rectifier changes DC current to alternating current.
23. Power factor and the efficiency of a welder are the same thing.
24. An example of a "drag" rod is the E6013.
25. Good housekeeping is always important in arc welding.
26. A weld with a "cold" start will have little penetration at the start of a weld.

Multiple Choice (circle the correct answer)

27. An iron powder rod:
    a) decreases the rate of metal deposition
    b) has a tendency to stick to the metal when welding
    c) is a fast freeze rod
    d) increases the rate of metal deposition

28. A low hydrogen rod is the:
    a) E6013 b) E7014 c) E7018 d) E7024 e) none of these

29. Which of the following should be considered in the selection of an electrode:
    a) type of metal to be welded
    b) position
    c) thickness of metal
    d) appearance
    e) all of these

30. An E6013 is a:
    a) fast-freeze
    b) fast-fill
    c) fill-freeze
    d) none of these

31. The third digit on an E7024 electrode indicates the:
    a) position that the rod can be used in
    b) type of welding current
    c) tensil strength
    d) penetration

32. Open circuit voltage is the voltage that is available:
    a) at the end of the electrode when the machine is on, with an arc being struck
    b) at the end of the electrode when the machine is on without an arc being struck
    c) at the end of the electrode when the machine is turned off
    d) none of the these

33. A 5/16" electrode will have a bead diameter of _____ and arc length of_____.
    a) 5/16 and 5/8
    b) 5/16 and 5/16
    c) 5/8 and 5/32
    d) 5/8 and 5/16

34. When welding at low amperages in the flat position, a long arc causes:
    a) a convex bead
    b) slag inclusions, excessive spatter, and poor penetration
    c) undercutting
    d) cracks

35. Proper amperage selection depends on:
    a) type of electrode
    b) size of electrode
    c) position of electrode when welding
    d) all of these

36. Undercutting is caused by:
    a) low amperage
    b) high amperage
    c) long arc
    d) b and c

37. Which of the following is a fast freeze electrode:
    a) 6011 b) 6013 c) 7024 d) 7018

38. Which of the following is not a factor in classifying steel electrodes:
    a) color
    b) type of welding current
    c) welding position of the electrode
    d) type of covering

39. "Duty Cycle" is really a measure of:
    a) % of a ten-minute period the welder can perform
    b) arc blow
    c) temperature rise
    d) all of these

40. Open circuit voltage is important in:
    a) depth of penetration
    b) electrode selection
    c) striking the arc
    d) none of these

41. A long arc results in:
    a) large globules of electrode melting
    b) excess spatter
    c) irregular bead
    d) all of these

42. The primary advantage of a gas motor driven DC generator welder is:
    a) few moving parts
    b) freedom from arc blow
    c) flexibility
    d) none of these

43. Successful arc welding depends upon:
    a) amperage
    b) angle of electrode
    c) metal identification
    d) all of these

44. A great deal of light from the arc site means:
    a) excess arc length
    b) slow deposition rates
    c) poor penetration
    d) all of these

45. "Sticking" of the electrode may result from:
    a) amperage to high
    b) speed to fast
    c) amperage to low
    d) to thick of metal

46. Which of the following is not a method of controling arc blow?
    a) switch to AC
    b) relocate ground & weld toward it
    c) hold a long arc
    d) reduce the current setting

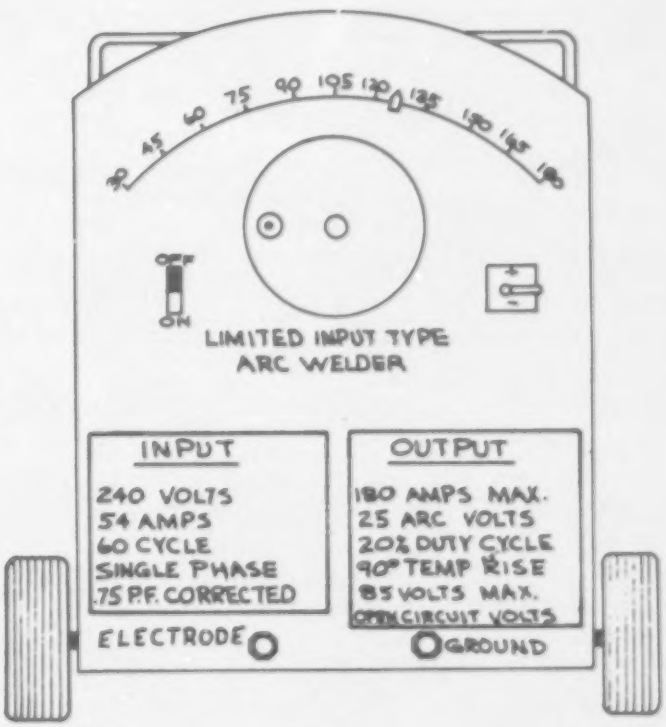
47. Which of the following is not an advantage of an AC welder:
    a) minimum of movable parts
    b) freedom from arc blow
    c) low initial cost as compared to other welders
    d) well suited for thin gage metal

48. An advantage of GMAW or MIG welding when using (non flux cord wire)
    a) no electrode stub loss
    b) no slag removal
    c) little smoke
    d) all of these

49. To control distortion:
    a) clamp in position
    b) have welds oppose each other
    c) a & b
    d) none of these

50. Which of the following is <u>not</u> one of the three rules for reducing distortion:
    a) balance distortion forces with other forces
    b) reduce effective distortion forces
    c) make distortion work for you
    d) increase the number of passes

Use the following nameplate information to answer the following questions:



51. The open circuit voltage on this machine is:
    a) 240 b) 25 c) 85 d) 54

52. The maximum amperage that is available to the operator when welding is:
    a) 225 b) 180 c) 54 d) 60

53. At 20% duty cycle this welder can run:

    a) 2 minutes straight for every 10 minutes
    b) 8 minutes straight for every 10 minutes
    c) 7.5 minutes straight for every 10 minutes
    d) none of these

54. This machine has a power factor of:

    a) 60 b) .20 c) .75 d) 1

55. While welding is being done the voltage of this machine is:

    a) 240 b) 25 c) 85 d) 54

Matching

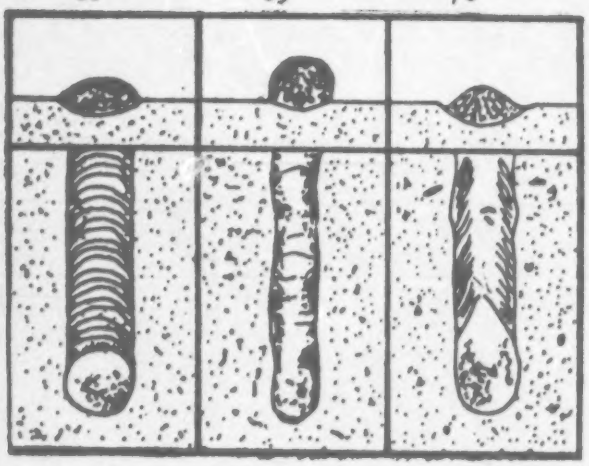
56.	Amount of current that flows in a circuit	A. circuit
57.	Force that causes current to flow	B. polarity
58.	Path of electron flow	C. voltage
59.	The direction of electron flow	D. amperage

60.	Associated with 60 cycles per second	A. AC
61.	2/3 of the heat in the work	B. DCRP
62.	Welding sheet metal	C. DCSP
63.	Electric arc cutting	D. E6013

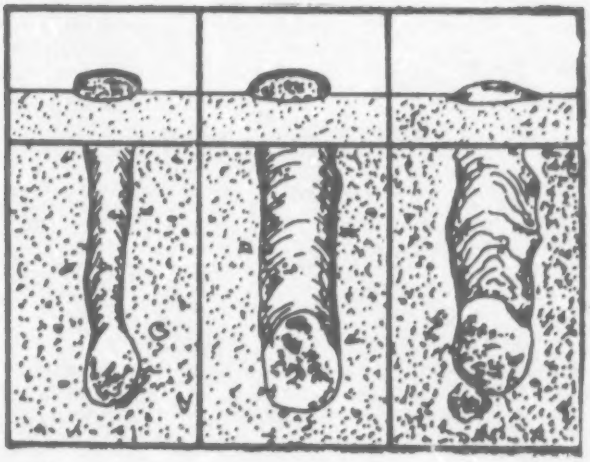
64.	lead angle on a flat butt weld	A. 90°
65.	work angle on a flat T-fillet weld	B. $30\text{-}45^{\circ}$
66.	work angle on a flat lap weld	C. 15°
67.	lead angle on a flat T-fillet weld	D. 5°

DIRECTIONS: Identify the problem with each of these welds. Circle the correct letter

68 69 70



71 72 73



68.	A. amperage low	71.	A. unclean metal
69.	B. amperage high	72.	B. slow speed
70.	C. normal bead	73.	C. long arc
	D. unbeveled metal		D. fast speed

---

74. An electric welding arc has a temperature that is:
    a) twice the melting point of mild steel
    b) 5900^{o} - $6200^{o}F$
    c) $11,000^{o}C$
    d) $11,000^{o}F$

75. Which of the following electrodes is not suited for use on an AC welder:
    a) E6010 b) E6011 c) E6012 d) E6013

76. The electrode commonly known as a drag rod which has a flux coating with a high iron powder content is:
    a) E7030 b) E9017 c) E11010 d) E7024

77. What is the numerical classification of an electrode bearing a blue spot in the secondary color marking position?
    a) E7018 b) E6010 c) E6013 d) E6011

78. GMAW or MIG welding:

a) uses a consumable bare wire electrode
b) uses a non-consumable electrode
c) has little electrode loss
d) a and c
e) b and c

79. Cast iron electrically welded should be ground to _____ angle and fit up prior to preheating.

a) 15^{o}
b) 30^{o}
c) 50^{o}
d) 60^{o}

80. Which of the following electrodes can be used when welding cast iron with an arc welder.

a) Eni
b) E7018
c) E6011
d) a and b
e) none of the above